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ABSTRACT

A study was conducted at a women's college to compare contrasting ideas of general education curriculum requirements: the prescribed core curriculum in which all students take the same courses versus the distributive model in which students are required to choose a minimum number of courses within specified academic areas. Graduating seniors were classified on the basis of Scholastic Aptitude Test scores for both Math and Verbal sections as either High/High (N=73) or Low/Low (N=29). College courses students had taken were grouped according to the gains reflected as graduating seniors on nine Graduate Record Examination (GRE) item types to determine which of the competing hypotheses explain student course taking behavior. Findings supported the distributive model. However, they did not support the current use of a wide range of options in distributional general education requirement. Instead findings suggested that discrete arrays of coursework be identified which are more appropriate and productive for different ability levels of students. Includes 21 references. (LPT)

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GENERAL LEARNING AT A WOMEN'S COLLEGE

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Women's colleges came about because of the differential status of women in nineteenth century American society. Some educators believed women to be intellectually inferior to men. Harvard professor Edward H. Clarke argued that women had a delicate constitution and would be irreparably damaged by the mental and physical strains of college life. Henry Tappan, president of the University of Michigan, argued that women were of lesser intellectual ability and stamina than men; admitting them to college would lower collegiate academic standards. In rejoinder to these arguments were early feminists, such as Lucinda Stone and Sarah Dix Hamlin, who argued that women's status in society was artificially limited and that through higher education women could become social leaders (Brubacher and Rudy 1976).

Most women's colleges began on the defensive. Bryn Mawr first established standards higher than any men's college as an answer to the discrimination against women's intellectual abilities. Colleges, such as Radcliffe, established curriculum comparable to the men's colleges. Others, Mt. Holyoke for example, stressed the sciences in order to overcome the stereotype that women were unsuited for such subjects as well as to encourage women to enter careers involving science (Jencks and Reisman, 1967).

Most women's colleges were founded in New England. In the West higher education tended to be coeducational and public. In the South, women's seminaries were the rule. By 1872, nearly half of the schools designated as seminaries had changed their name to "college". Prior to the twentieth century there was a Southern Association of Colleges for Women, the majority of whose members were not recognized by the Southern Association of Colleges and Secondary Schools. Many of these Southern institutions emphasized the development of women's social skills and gracious living. Similarly, Catholic women's colleges, which constituted third-fourths of women's colleges in the

1960's stressed "learning to live together" (Reisman and Jencks, 1967, p. 97), rather than the more traditional goals of a liberal arts curriculum. These institutions cast upon women's colleges in general the stereotype of a finishing school rather than a serious academic environment.

The New England women's colleges and western institutions, such as Mills College, stood in sharp contrast to the genteel tradition of Southern and Catholic female institutions. Robert Kelly (1940, p. 62-63) remarked on the similarity in missionary zeal in the development of denominational colleges and of women's colleges such as Wellesley, Vassar and Bryn Mawr. The transformation of women's colleges at the turn of the century into institutions of higher education occurred coterminously with the women's suffrage movement. It was the Women's Education Association of Boston, for example, who pressed President Elliot of Harvard to administer the Harvard entrance examinations to women. By 1879, the Harvard Annex (to be renamed Radcliffe College) was established through the support of such public figures as Mrs. Louis Agassiz and Miss Alice Longfellow (Morrision, 1936).

While there was always a presupposition that the campus life and college environment of a women's college was different, there have never been substantive differences in the liberal arts curriculum of colleges for women and colleges for men. Women's colleges differed in constructive forms of experimentation in curricular and extracurricular activities. There is evidence to indicated that these colleges have attended to the needs of individual students in ways not found on coeducational campuses (Kelly, 1940).

Is there a single most effective pattern of undergraduate general education for a given group of women students? Do students in a women's college develop their general learned abilities in a manner comparable to students who attend other forms of higher education. There is no uniform general education

curriculum for college students today and a debate has continued concerning the structure and content of general education as discussed by numerous reports (Association of American Colleges, 1988; National Institute of Education, 1984; National Endowment for the Humanities, 1984; American Colleges Committee's Project on Redefining the Meaning and Purpose of Baccalaureate Degrees, 1985).

At one end of the continuum, there are advocates for a core curriculum who believe that general education should consist of prescribed coursework required of all students (Boyer & Kaplan, 1977; National Endowment for the Humanities, 1989). They believe that one curriculum is appropriate for all students. Others support the distributive model which consists of "requirements designed to ensure that each student takes a minimum number of courses or credits in specified academic areas" (Levine, 1978, p. 11). At many colleges and universities students may choose from hundreds of courses from a wide variety of subjects to fulfill distribution requirements. The advocates of the distributive requirements believe that different curricula are necessary for different student interests and/or student abilities. This paper presents a model and a case for examining student transcripts and tests scores to determine the extent to which common general education coursework affects the general learned abilities of high and low ability college students. The environment in which this examination takes place is a selective women's liberal arts college. Parallel questions emerge relative to the breadth and depth of subjects studied at the college and the relative gains in general learning experienced by the majority of students at the college.

Problem Investigation

Given the contrasting views of the core curriculum advocates and the advocates of the distributive requirements, the fundamental question is which view of the curriculum is superior for students with different levels of abilities. An attendant question is whether there is evidence that a particular curricular configuration is more appropriate at a women's college. The supporters of the core curriculum would hypothesize that both high ability and low ability students would gain from taking the same sets of courses. The supporters of the distributive requirements hold that different coursework is appropriate for the development of students of different abilities. This research sorts the courses students took according to the gains they showed on 9 measures of general learning to determine which of these competing hypothesis explain student course taking behavior at a comprehensive college. The model of analysis has been applied to other institutional settings wherein a distributional form of general education is present to determine the effect of coursework on learning.

Framework

No single curricular model and no single analytical process clearly identifies the effect of coursework patterns on the general learned abilities of students. Ratcliff (1987) developed a cluster analytic model to determine the effect of college coursework on the development of multiple criteria of general learned abilities. This model has been reliably used within the context of a variety of higher education institutions and student populations (selective, non-selective, single-gender, research universities, liberal arts colleges, comprehensive colleges) (Ratcliff, 1988). Courses students selected were identified using their official transcripts. Nine broad measures of general

learning were taken from these students SAT and GRE scores. The courses they took were matched and analyzed according to the residual gains in their learned abilities.

Sample

A random sample of 146 graduating seniors was drawn from a private comprehensive college I. For the purposes of this study, we will call this institution Women's College. The sample comprised approximately 14 percent of the graduating seniors during the 1987-1988 academic year at Women's College. The sample proved to be analogous to the distribution of Scholastic Aptitude Test (SAT) scores, majors, and other socioeconomic characteristics of the population of graduating seniors at Women's College.

Two subsamples were drawn from the main sample. One subsample consisted of 73 students who scored above the means on both SAT-Math and SAT-Verbal. They were classified as the High/High group. The second subsample consisted of 29 students who scored below the means on both SAT-Math and SAT-Verbal. They were classified as the Low/Low group. These two subsamples constituted 70 percent of the total sample.

Differences in Women's College Low/Low and High/High Subsamples Characteristics

A brief description of the characteristics of the Women's College subsamples reveals some differences between the High/High and Low/Low groups. Gender is a factor related to academic performance. Over two-thirds (67.1%) of the High/High group were female, while 75.9 percent of the Low/Low group were female.

Ethnicity is also related to academic performance. One percent of the High/High group were non-white, while seven percent of the Low/Low students were non-white (see Table 1). Non-whites constitute about 3% of Women's College's

graduating seniors. The majority of non-white students were in the Low/Low group.

Major field of study has been shown to be correlated to performance in the GRE examinations. However, the distribution of majors in the High/High group approximated that of the Low/Low group.

The overwhelming majority of these student subsamples entered Women's College in the Fall 1984 term. One percent of the High/High group entered in the Fall 1985 term and were proceeding on an accelerated schedule. Only 11 percent of the High/High students and 10 percent of the Low/Low students took longer than four years to complete their bachelor's degree.

Students in the High/High and Low/Low groups were clearly planning some form of post-baccalaureate study (see Table 2). Over three-quarters (76.7%) of the High/High students and 82.8 percent of the Low/Low students planned a master's degree, while nearly one-fifth (19.2%) of High/High students and 13.8 percent of Low/Low students planned a doctoral program. The two subgroups did vary in their expectations for subsequent graduate study.

The educational attainment of parents has been shown to be positively correlated to student achievement in college. Nearly one quarter (23.3%) of the fathers and 15.1 percent of the mothers of the High/High group had attained a graduate or professional degree while over one-third (37.9%) of the fathers and 6.9 percent of the mothers of Low/Low students had attained a graduate or professional degree. Over one-third (37.0%) of the fathers and 21.9 percent of the mothers of High/High students had attained at least a bachelor's degree while 13.8 percent of the fathers and 34.5 percent of the mothers of Low/Low students did complete the bachelor's degree (see Table 3). Clearly, the educational aspirations of these Women's College students were higher than the educational attainment of either of their parents. It should also be noted that

greater proportions of the Low/Low students intended to seek the Masters Degree, while greater percentages of the High/High group sought the doctorate.

The majority of both High/High and Low/Low students possessed little full-time work experience. Over four-fifths (84%) of High/High students and 55 percent of Low/Low students had held summer jobs. Four percent of the High/High students and one percent of the Low/Low students had full-time work experience prior to attending college. Higher proportions of the high ability group had higher levels of educational attainment.

These two groups also varied in the amount of community service performed. Community service generally reflects social and altruistic values of the students. Over two-fifths (44%) of the High/High students and 52 percent of the Low/Low students had performed some community service during the past year, but for 31 percent of the High/High students and 38 percent of the Low/Low students this comprised less than five hours per week (see Table 4). Nearly one-half (45%) of the High/High students and 34 percent of the Low/Low students had earned some form of professional, community service, literary, artistic, or student government honor, or award. The High ability students were more prone to honors and awards, while the Low/Low students were more involved in community service.

TABLE 1
Distribution of Women's College Subsamples by Ethnicity.

ETHNICITY	Low/Low N	Low/Low Percent	High/High N	High/High Percent
Not specified	0	.00%	0	.00%
Black	11	31.43%	0	.00%
Chinese American	0	.00%	0	.00%
Japanese American	0	.00%	0	.00%
Other Asian American	0	.00%	1	2.70%
Native American	0	.00%	0	.00%
Chicano/Hispanic	3	8.57%	3	8.11%
White	21	60.00%	33	89.19%
Foreign	0	.00%	0	.00%
TOTALS	35	100.00%	37	100.00%

TABLE 2
Degree Objectives of Women's College Subsamples

DEGREE OBJECTIVES	Low/Low N	Low/Low Percent	High/High N	High/High Percent
Unknown	2	5.71%	1	2.70%
Nondegree study	3	8.57%	3	8.11%
Masters degree	21	60.00%	18	48.65%
Intermediate degree (e.g. Specialist)	0	.00%	1	2.70%
Doctorate (Ph.D., Ed.D.)	9	25.71%	14	37.84%
Postdoctoral study	0	.00%	0	.00%
TOTALS	35	100.00%	37	100.00%

TABLE 3
Educational Attainment of Parents of Women's College Subsamples

HIGHEST LEVEL OF EDUCATION COMPLETED	Low/Low				High/High			
	Father		Mother		Father		Mother	
	N	Percent	N	Percent	N	Percent	N	Percent
No response	1	2.86%	0	.00%	0	.00%	0	.00%
Grade school or less	0	.00%	0	.00%	0	.00%	1	2.70%
Some high school	0	.00%	2	5.71%	0	.00%	1	2.70%
High school diploma or equivalent	6	17.14%	4	11.43%	5	13.51%	3	8.11%
Business or trade school	2	5.71%	1	2.86%	0	.00%	0	.00%
Some college	2	5.71%	9	25.71%	5	13.51%	7	18.92%
Associate degree	1	2.86%	2	5.71%	4	10.81%	4	10.81%
Bachelor's degree	7	20.00%	7	20.00%	4	10.81%	4	10.81%
Some graduate or professional school	1	2.86%	2	5.71%	3	8.11%	7	18.92%
Graduate or professional degree	15	42.86%	8	22.86%	16	43.24%	10	27.03%
TOTALS	35	100.00%	35	100.00%	37	100.00%	37	100.00%

TABLE 4
Community Service Activities of Women's College Subsamples.

HOURS PER WEEK IN COMMUNITY SERVICE ACTIVITIES OVER THE PAST YEAR:	Low/Low N	Low/Low Percent	High/High N	High/High Percent
No response	2	5.71%	1	2.70%
0 hours	13	37.14%	18	48.65%
1 - 5 hours	15	42.86%	14	37.84%
6 - 10 hours	2	5.71%	3	8.11%
11 - 20 hours	3	8.57%	0	.00%
More than 20	0	.00%	1	2.70%
TOTALS	35	100.00%	37	100.00%

Overview of Methodology and Procedures

While incoming student ability of the sample was controlled by SAT scores, the exiting student achievement was measured by the General Test of the Graduate Record Examination (GRE) scores. Specifically, the residual differences from the predicted and observed scores on the nine item-types within the General Test (of the GRE) served as the measures of exiting student achievement. In the Verbal section of the GRE, the four item-types were Analogies, Sentence Completion, Reading Comprehension, and Antonyms. In the Quantitative section of the GRE the item-types were Quantitative Comparison, Regular Mathematics, and Data Interpretation. In the Analytic section, the item-types were Analytical Reasoning and Logical Reasoning. These nine GRE item-type residual scores represented the gains students experienced in general learned abilities from the time they entered college to the time of GRE testing during their senior

year.

Some would argue that the GRE measures a narrow range of learned abilities deemed only appropriate to graduate study (Adelman, 1985). Others have attacked the SAT as a biased, limited, or inappropriate measure of general learning (Crouse, 1988). While standardized tests may have their antagonists and proponents, it was not our aim to suggest that either of these tests was the only, the best, or the primary measure of what students learn in college. Locally developed measures of general learning were not available at Women's College. Grades had proved too unreliable in prior research (Prather & Smith, 1976; Prather, Williams & Wadley, 1976). All their critics aside, most colleges are inclined to make admission decisions in part on the basis of SAT scores, and the GRE remains the most widely used test of general learning after the baccalaureate. It was for these pragmatic reasons, together with the need to use a set of pre-college measures comparable to a post-college measure that these tests were selected.

The courses that these Women's College students selected were identified using their transcripts. The unit of our analysis was each single course. For the purposes of analysis, each course was regarded as having nine attributes represented by the nine GRE residual item-type scores of students who enrolled in that course. Courses with sufficient enrollment by the student sample (5 or more students) were grouped according to the collective item-type scores of the students enrolling in the course. Cluster analysis was used to do this grouping. The cluster analysis permitted us to identify which courses were taken by students making significant gains in one or more types of general learning measured. In short, the cluster analytic model allowed us to examine the college curriculum using student decision-making behavior (represented on

the student transcripts) as the primary source of information.

Student Performance on the GRE Examinations

Prior to partialling the effects of the students' SAT scores from their GRE item-type scores, the reliability of the GRE item-types were computed for the separate Samples #1 and #2. This procedure was necessary since different questions were used in the GRE. Alpha scores above .60 were used to indicate measures with acceptable levels of reliability. Low alpha scores were reported for Regular Mathematics (Sample #1), Data Interpretation (both samples) and Logical Reasoning (Sample #2) (see Table 5).

TABLE 5
Reliability of Coefficients for GRE item-types in the Sample #1 and Sample #2 groups of Women's College

GRE Item-types	Code	CRONBACH'S ALPHA Sample #1 23 students	Sample #2 53 students
Analogy	ANA	.6126	.6402
Sentence Completion	SC	.5980	.7251
Reading Comprehension	RD	.7013	.7781
Antonyms	ANT	.8257	.6944
Quantitative Comparison	QC	.6968	.7387
Regular Mathematics	RM	.4971	.6207
Data Interpretation	DI	.1817	.3592
Analytical Reasoning	ARE	.8021	.7742
Logical Reasoning	LR	.6065	.4057
GRE Verbal	GRE-V	.8852	.8902
GRE Quantitative	GRE-Q	.7575	.8208
GRE Analytic	GRE-A	.8261	.7912

The High/High group performed well on the GRE General Examinations while the Low/Low group did not perform as well. On average, the Low/Low group

answered 84 of 186 items correctly; the High/High group gave correct responses to an average of 110 of the 186 items. Thus, the High/High group gave 26 to 37 more correct responses than did the Low/Low group. While an examination of these scores showed differences in the level of performance between the two groups, regression analysis revealed large difference in the types of learning as well.

Differences between the item-type scores for the High/High and Low/Low groups appeared when the effect of the precollege learning (as measured by the SAT) was removed. When the theoretical scores (as predicted by corresponding SAT scores) were compared with the students' actual responses, both subgroups showed large proportions of change on most item-types. However, the change was different ability areas.

Large probability of error was found in 5 of the 9 item-types residuals among the Sample Low/Low group, resulting in their exclusion from further analysis. Of these 4 Low/Low group item-types, the greatest amount of variance in item-type residuals, including the greatest standard error and standard deviation, were found in the Quantitative Comparison item-type. Among the High/High group, the greatest amount of variance occurred in the Analogies and Data Interpretation item-types. The Low/Low and High/High subgroups demonstrated very different profiles of change in general learned abilities. The High/High group demonstrated particularly high residuals on Reading Comprehension, Data Interpretation, and Logical Reasoning; the High/High group evinced the lowest proportional change on the Quantitative Comparison item-type. Low/Low group students showed the greatest gains in Quantitative Comparisons and the lowest gains in Regular Math. Students of different levels of ability upon entrance to college strengthened different types of general learned abilities while in attendance at Women's College.

The variance in the residuals holds implications for the ensuing cluster analysis GRE item-types with greater variance played a more influential role in sorting courses into clusters. As we discovered in the analyses of other institutions (Ratcliff & Jones, 1990, in press), those GRE item-types with smaller variance play less of a role in discriminating course clusters.

Table 6 compares the explained variance ($\underline{r}^2$) for each GRE item-type, raw GRE sub-score and converted GRE sub-score. In all cases within the subsamples of the Women's College where errors estimates were less than .05, the SAT accounted for more variance in GRE sub-scores than in the GRE item-type scores.

As this table demonstrates, from 9 percent (Logical Reasoning) to 44 percent (Analogies) of GRE item-type score variation among the High/High group was explained by SAT scores; from 10 percent (Analytic Reasoning) to 38 percent (Antonyms) of GRE item-type score variation among the Low/Low groups was explained by SAT scores. All regression functions were statistically significant at .05 with the exception of Data Interpretation.

Using the student residuals obtained from the regression analysis above, the mean residuals for each course enrolling 5 or more students were calculated for all the 9 GRE item-types. Such a procedure did not assume that the specific gains of the students enrolled in each course were directly caused by that course. Rather, the residuals of each student were attributed to all the courses in which they enrolled, and the mean residuals for each course served as a proxy measure of student gains. Once courses were clustered by these residuals, then hypotheses were generated and tested as to why students who enrolled in a given pattern of courses experienced significant gains on one or more of the outcomes criteria (i.e., the item-type residuals).

TABLE 6
Summary of Regression of GRE Item-types on SAT Subscores for Low/Low and High/High Groups of Women's College

Dependent Variables: GRE Item-types on SAT Sub-scores	CODE	Low/Low Group 35 Students F Value	Prob>F	Adjusted R-Squared	High/High Group 37 Students F Value	Prob>F	Adjusted R-Squared
GRE Item-type scores							
Sentence Completion	SC	7.469	.0100	.1599	11.183	.0020	.2205
Analogies	ANA	17.471	.0002	.3264	29.283	.0001	.4400
Reading Comprehension	RD	10.876	.0023	.2251	7.746	.0086	.1578
Antonyms	ANT	21.921	.0001	.3809	11.052	.0021	.2183
Quantitative Comparisons	QC	19.801	.0001	.3561	4.451	.0421	.0875
Regular Math	RM	8.706	.0058	.1848	4.752	.0361	.0944
Data Interpretation	DI	.091	.7644	-.0275	.302	.5862	-.0198
Analytic Reasoning	ARE	4.603	.0394	.0958	4.862	.0341	.0969
Logical Reasoning	LR	5.792	.0219	.1235	4.520	.0406	.0891
Raw Sub-test Scores							
Verbal	GRE-V	50.801	.0001	.5943	34.669	.0001	.4833
Quantitative	GRE-Q	20.831	.0001	.3684	5.551	.0242	.1122
Analytical	GRE-A	7.456	.0101	.1596	7.175	.0112	.1464

It is statistically more difficult for high ability students to show large percentage gains than it is for low ability students to do so. It is more difficult for a student in the 95th percentile on a test to advance to the 96th percentile in a subsequent retesting that it is for a student in the 50th percentile to advance to the 51st. For this reason, it was expected that the

High/High Group of students would have lower residual scores than the Low/Low Group. Nevertheless, the Women's College students of the High/High Group evidenced larger score residuals than did those of the total Sample. While part of these differences may be attributable to error resulting from the smaller number of students in the Low/Low groups, it is also offset by those few students achieving near perfect scores on one or more item-types. This data would suggest that among the High/High group are individuals who evidenced significant gains in general learned abilities while at Women's College. Furthermore, it may be that these high ability students found an educational experience that proved to be somewhat more beneficial to their counterparts in the Low/Low group. This finding was also confirmed in a subsequent cohort of High/High Women's College seniors.

Quantitative Cluster Analysis of the Low/Low and High/High Groups Women's College Subgroups

This section reports the use of the cluster analytic procedure to analyze the High/High and Low/Low groups of Women's College. The findings from the analysis of both subsamples are presented. The results for each subsample are compared to determine the extent to which students of different entering abilities benefit from different coursework patterns. Secondary validation (discriminant analyses) of the two subsamples suggested that the cluster analytic model was a reliable means for determining coursework associated with the general learned abilities of undergraduates. The objects of these analyses were the courses the students took. These courses constitute enrollment patterns for the Women's College students in the High/High and Low/Low groups.

There were 1,324 courses listed on the 35 transcripts of the students in the Low/Low group, indicating that, on average, each of these students had

enrolled in an average of 37.8 courses as part of the baccalaureate degree program; this compares with an average of 36.2 courses for the total Women's College sample. These students enrolled in 2-3 courses more in order to prepare to graduate. There were 1,313 courses listed on the 37 transcripts of the students in the High/High group, indicating that, on average, each of these students had enrolled in an average of 35.5 courses as part of the baccalaureate degree program; this compares with an average of 37.8 courses for the total Women's College sample.

There were 462 unduplicated courses on the Low/Low transcripts, 75 in which 5 or more students had enrolled. There were 453 unduplicated courses on the High/High transcripts, 84 in which 5 or more students had enrolled. These courses were the objects of further analysis for each group.

Discussion of Subgroup Residual Scores

Residuals represent the GRE item-type variance not explained by the corresponding SAT score. Residuals may be positive or negative. If they are positive, they indicate that the student's actual score exceeded its value predicted by the SAT. If the residuals are negative, they indicate that the students performance on the GRE item-type was less than that predicted by the corresponding SAT score. Thus, residuals may express either positive or negative change of a student's general learned abilities relative to the sample group.

The average of residuals means for the Women's College Low/Low subgroup was positive. There were positive residuals on Antonyms, Data Interpretation, and Logical Reasoning. This group showed declines in the Sentence Completion, Analogies, Reading Comprehension, Regular Mathematics, Quantitative Comparisons,

and Analytic Reasoning item-types.

The Women's College High/High subgroup showed positive residuals only on the Antonyms, Analogies, Regular Mathematics, and Analytic Reasoning item-types. While the residual means describe the direction of change in general learned abilities (positive or negative), the standard deviation of residuals give estimates of the variation in change. The greatest variation in residuals occurred among the High/High subgroup. The greatest variation for both groups occurred in the Analytic Reasoning item-type. This finding was similar to that at a research university (Jones & Ratcliff, 1990) and a comprehensive college (Ratcliff & Jones, in press), suggesting that the greatest gains in general learned abilities were in comparable learning types. Greater gains were shown in Data Interpretation, but the variation in score residuals exceeded the error estimate boundaries, preventing further analysis of learning in this area. Change in general learned abilities was greatest in Analytic Reasoning and among High/High students. For these students, the effect of the undergraduate experience varied between the High/High subgroup and the Low/Low subgroup.

The Women's College students in the subgroups did not register strong positive gains, once the effect of their precollege SAT scores were removed. Nevertheless, some students gained and some students declined in general learned ability (relative to the mean of all students) within both subgroups. Because the highest score variance was on the Analytic Reasoning item-type, this item-type predominated in the ensuing cluster analyses. These cluster analyses differentiated between courses taken by students who showed gains on the item-types and those who declined. While the sum of all residuals is zero, when residuals were aggregated by course, some courses had positive mean residuals while others had negative mean residuals for the students who enrolled in them.

The courses with 5 or more students had slightly positive average mean course residuals. This indicated that the average Women's College student did select common coursework (that taken by other students in the sample) that was associated with gains in general learned abilities especially in the Low/Low group. Coursework unique to individual students (that in which less than 5 students from the sample enrolled) were not linked to gains in general learning.

Creating the Raw Data Matrix and the Resemblance Matrix for the Low/Low and High/High Groups

A first step in conducting cluster analysis is to construct a matrix of courses and mean GRE item-type residual scores. A raw data matrix was created using the mean residuals of the Women's College Low/Low group and the 75 courses found on 5 or more of their student transcripts. The data matrix consisted of 75 columns and 9 rows (75 x 9). A second separate raw data matrix was created using the mean residuals of the High/High group and the 84 courses found on 5 or more of their student transcripts. This data matrix consisted of 84 columns and 9 rows (84 x 9). The rows represented the criterion variables: the 9 GRE item-type scores. The columns represented those courses enrolling 5 or more students. Thus, each cell value of the matrix was a mean GRE item-type score gain for those sample group students enrolling in a specific course.

The next step in cluster analysis is to transform the raw data matrix into a resemblance matrix so that the similarities of individual courses can be determined. The correlation coefficient was used as the similarity measure for the resemblance matrix. This coefficient assessed a pattern similarity of any two courses explained in terms of the 9 GRE item-type residuals. The resemblance matrices produced in this step consisted of 75 rows and 75 columns for the Low/Low group and 84 columns and 84 rows for the High/High group, in

which each cell value theoretically ranged from -1.00 to 1.00. The calculation of the resemblance matrix was done using the SPSSx PROXIMITY program.

Separate cluster analyses were conducted for High/High and Low/Low groups using the resemblance matrices' data. The method selected for the cluster analyses was the average linkage method (**UPGMA**). The cluster analysis dendrograms of both groups' courses were produced by SPSS-X.

Low/Low Group Cluster Analysis

The results of the cluster analysis of the Low/Low group of Women's College is briefly described. Courses were classified into 9 coursework patterns according to a hierarchical cluster structure. In fact, the choice to present the data in 9 clusters was arbitrary. Any number of clusters can be identified depending on the hierarchical cluster structure produced; this structure remains constant regardless of the number of clusters used to form coursework patterns. A procedure for selecting the optimum number of clusters and for validating the resulting patterns will be described in greater detail in a subsequent section on the discriminant analysis of the coursework patterns in the Low/Low subgroup.

Using a 9-cluster solution to the quantitative cluster analysis, the largest number of courses were in Coursework Clusters #6 with 19 courses and Cluster #5 with 15 courses. The smallest clusters were the 4th, 8th, and 9th clusters with 5, 3, or 4 courses each. Overall, the differentiation between clusters was attributable to the number of criterion variables used in the analysis and also to the choice of those variables. The cluster analysis and subsequent discriminant analysis suggested that student residual scores on GRE item-types were strong, reliable and robust measures in differentiating student general learned abilities.

The hierarchical cluster structure was represented in a dendrogram. The dendrogram displayed the clusters being combined and the distances between the clusters at each successive step, suggesting that the 8-cluster solution examined was appropriate and interpretable. Cluster analyses using smaller and larger numbers of cluster groupings provided comparably high levels of correct classification, as determined by subsequent discriminant analyses. However, as the resemblance index increases (Euclidean distance between courses), more distant courses were joined into larger and larger clusters. A 12-cluster solution, for example, provided a high degree of aggregation and a comparable a high degree of predictive validity but a low level of utility in differentiating coursework by item-type.

Some courses coming from the same department appear in the same cluster, such as the Math and Computer Science courses (M&CS) and Economic courses (ECON) in Cluster #7 (see Table 7). Similarly, there were apparent sequences of courses, such as the Econ 121, 122 sequence in Cluster #3. Also, a set of courses coming from various related disciplines may form a homogeneous cluster on the basis of a set of given attributes or criteria.

High/High Group Cluster Analysis

For the High/High group a 9-cluster solution was used. The largest number of courses were in Coursework Clusters #2 and #5 with 16 and 19 courses, respectively. The smallest clusters were the 4th cluster with 1 course and the 8th cluster with 2 courses. Some of High/High subgroup courses from the same department appear in the same cluster, such as the Math and Computer Science courses in Cluster #2 (see Table 8). Similarly, there were apparent sequences of courses, such as the Chemistry 13, 14, 15, 16 sequence in Cluster #2. Also, a set of courses coming from various related disciplines may form a homogeneous

cluster on the basis of a set of given attributes or criteria. Some rudiments of disciplinary association with the clusters and of course sequence were evident in several clusters. However, at this point in the analysis, it was difficult to describe which dimensions of student general learned ability each cluster represents. Still, it seemed clear that one pattern of course enrollment contributed to student general learned ability in a way significantly different from the other coursework patterns. Supporting this finding was a more detailed examination of subset courses of each clusters. In many cases, those courses offered at the same level often were combined into pairs together. But, those pairs were agglomerated with other courses offered at the higher level again according to the hierarchical structure of clusters. Student gains in general learned abilities of both groups were more likely a result of a sequential enrollment pattern during the college years, not at a single stage of the sequence (such as the freshman year experience).

TABLE 7
Coursework Patterns: 9-cluster for the Women's College Low/Low group

Cluster #1 n = 7		Cluster #2 n = 4		Cluster #3 n = 7		Cluster #4 n = 5	
Anth	58	Arth	18	Arth	81	Arts	164
Arth	19	Arth	82	Arts	5	Eng	62
HMS	102	Dra	63	Fren	3	Eng	148
HMS	12 A	Eng	61 X	Hist	147	Fren	1 *
Phil	9			HMS	16 A	Hist	11
Phys	10			Soc	147		
Soc	61			Soc	55		

Cluster #5 n = 15		Cluster #6 n = 19		Cluster #7 n = 10		Cluster #8 n = 3	
Arts	91	Bio	63	Comm	31 *	Comm	85
Bio	2	DNC	4	Dra	46	Eng	88
Bio	101	Dra	65	Econ	73	Soc	94
Chem	13	Econ	51	Econ	116		
Chem	15	Econ	52	Econ	135	**Cluster #9** n = 1	
Eng	102	Eng	1	Econ	136		
HMS	9	Eng	5	Econ	155	Govt	86
HMS	40	Eng	10	Econ	163	Govt	102
M&CS	4	Eths	51	Eths	124	Psyc	81
M&CS	8	Govt	17	Phys	61	Sosc	122
M&CS	48	Govt	101				
M&CS	62	HMS	7 B				
M&CS	64	HMS	12 B				
Phil	62	HMS	26 A				
Psych	49	M&CS	3				
		M&CS	5				
		M&CS	47				
		M&CS	63				
		Span	101				

"*" following a course indicates a course misclassified according to the discriminant analysis of course clusters.

TABLE 8
Coursework Patterns: 9-cluster for the Women's College High/High group

Cluster #1 n = 5		Cluster #2 n = 16		Cluster #3 n = 9		Cluster #4 n = 1	
Anth	57	Anth	58	Arth	82	Arts	91
Arts	5	Arth	18	DNC	1		
Eng	10	Arth	19	DNC	16		
Hist	11	Bio	2	Dra	46		
Mus	27 E	Chem	13	Eng	1		
		Chem	14	HMS	12 A		
		Chem	15	HMS	26 A		
Cluster #5		Chem	16	Mus	27 B *		
n = 19		Chem	101	Soc	61		
		Chem	103				
Bio	63	DNC	5	**Cluster #7**		**Cluster #8**	
Bio	101	DNC	6 *	n = 10		n = 2	
Econ	51	Eng	11				
Econ	52	Fren	9	DNC	102	Fren	1
Econ	135	HMS	11	Eng	55	Hist	123
Econ	163	Let	9	Eng	61 X		
Govt	17			Eng	116	**Cluster #9**	
Govt	90			Eng	192	n = 11	
Govt	102	**Cluster #6**		Fren	3		
HMS	102	n = 10		Fren	4	HMS	68
M&CS	3			Fren	57	M&CS	4
M&CS	5	Bio	37	HMS	12 B	M&CS	8
M&CS	47	Comm	31	M&CS	62	M&CS	47 T
M&CS	48	Educ	190			M&CS	48 T
Mus	2	Eng	110			M&CS	63 *
PE	102	Eng	115			M&CS	64
Psyc	49	Fren	2			M&CS	111
Psyc	81	Fren	51			M&CS	113
Sosc	93	HMS	16 A			M&CS	151
		Psyc	80			Phys	61
		Psyc	157				

"*" following a course indicates a course misclassified according to the discriminant analysis of course clusters.

Discriminant Analysis of Coursework Patterns for the Low/Low and High/High Groups

In examining the dendrograms of the Women's College Low/Low group and the High/High group, a logical question arises as to which number of clusters or

pattern groupings provides the best explanation of the relationship between student item-type residuals and coursework patterns. Separate discriminant analyses of different numbers of cluster groupings were performed in order to determine the number of groupings that optimizes the proportion of courses correctly classified. Three different cluster solutions for the Low/Low group and three different cluster solutions for the High/High group provided comparably high levels of correct classification.

Low/Low Group

9-cluster solution : 97.62% of courses correctly classified
11-cluster solution : 96.43% of courses correctly classified
13-cluster solution : 96.43% of courses correctly classified

High/High Group

9-cluster solution : 97.33% of courses correctly classified
11-cluster solution : 97.33% of courses correctly classified
13-cluster solution : 97.33% of courses correctly classified

While these cluster solutions produced comparable classification results, the different grouping evidenced differing effectiveness in identifying relationships between mean item-type residuals and coursework patterns. For the Low/Low group, 8 of 9 item-type residuals conformed to the linear model. Therefore, analysis for this group omitted the effects of the Data Interpretation item-types. The 9-cluster solution proved to provide the greatest extent of information about the relationships between these residuals and coursework patterns and was therefore used in this research. For the High/High group, the 13-cluster solution proved to provide the greatest extent of information about the relationships between residuals and coursework patterns and was therefore used.

Discriminant analysis was (the DISCRIMINANT program in SPSSx) in the following manner. Discriminant functions were applied to the data using the course item-type attributes as independent variables and the cluster group

membership as the dependent variables.

TABLE)
Discriminant analysis of the 9-cluster solution for the Low/Low group

Actual Cluster	No. of Cases	Predicted Group Membership Gr 1	Gr 2	Gr 3	Gr 4	Gr 5	Gr 6	Gr 7	Gr 8	Gr 9
Group 1	7	**7**	0	0	0	0	0	0	0	0
		100.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%
Group 2	5	0	**5**	0	0	0	0	0	0	0
		.0%	**100.0%**	.0%	.0%	.0%	.0%	.0%	.0%	.0%
Group 3	7	0	0	**7**	0	0	0	0	0	0
		.0%	.0%	**100.0%**	.0%	.0%	.0%	.0%	.0%	.0%
Group 4	5	0	0	0	**4**	0	0	0	1	0
		.0%	.0%	.0%	**80.0%**	.0%	.0%	.0%	20.0%	.0%
Group 5	15	0	0	0	0	**15**	0	0	0	0
		.0%	.0%	.0%	.0%	**100.0%**	.0%	.0%	.0%	.0%
Group 6	19	0	0	0	0	0	**19**	0	0	0
		.0%	.0%	.0%	.0%	.0%	**100.0%**	.0%	.0%	.0%
Group 7	10	0	0	0	0	0	1	**9**	0	0
		.0%	.0%	.0%	.0%	.0%	10.0%	**90.0%**	.0%	.0%
Group 8	3	0	0	0	0	0	0	0	**3**	0
		.0%	.0%	.0%	.0%	.0%	.0%	.0%	**100.0%**	.0%
Group 9	4	0	0	0	0	0	0	0	0	**4**
		.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	**100.0%**
Total	75									

Percent of "Grouped" Clusters correctly classified: 97.33%

TABLE 10
Discriminant analysis of the 9-cluster solution for the High/High group

Actual Cluster	No. of Cases	Predicted Group Membership Gr 1	Gr 2	Gr 3	Gr 4	Gr 5	Gr 6	Gr 7	Gr 8	Gr 9
Group 1	5	5 100.0%	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%
Group 2	16	0 .0%	15 93.8%	0 .0%	0 .0%	0 .0%	0 .0%	1 6.3%	0 .0%	0 .0%
Group 3	9	0 .0%	0 .0%	9 100.0%	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%
Group 4	1	0 .0%	0 .0%	0 .0%	1 100.0%	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%
Group 5	19	0 .0%	0 .0%	0 .0%	0 .0%	19 100.0%	0 .0%	0 .0%	0 .0%	0 .0%
Group 6	10	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%	10 100.0%	0 .0%	0 .0%	0 .0%
Group 7	10	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%	10 100.0%	0 .0%	0 .0%
Group 8	3	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%	0 .0%	3 100.0%	0 .0%
Group 9	11	0 .0%	0 .0%	0 .0%	0 .0%	1 9.1%	0 .0%	0 .0%	0 .0%	10 90.9%
Total	84									

Percent of "Grouped" Clusters correctly classified: 97.62%

Nearly 98 percent of the classification of courses was correctly predicted by cluster analysis for the Low/Low group while for the High/High group 90.32 percent of the classification was correctly predicted. Nine of ten courses most frequently taken by students in both subsamples were correctly grouped according to their mean residual GRE scores. The cluster analysis produced coursework patterns according to criteria of general student learning. Additional steps

were needed (1) to determine which courses were correctly classified and (2) to ascertain which item-type scores contributed to any given coursework pattern.

Using the BREAKDOWN procedure in the DISCRIMINANT program of SPSS-X (Norisus 1985), courses which were incorrectly classified or which were classified within another coursework pattern were identified. To compute the contribution of each mean item-type residual score to the discriminant functions, the correlation coefficients between mean residual scores and discriminant functions were examined.

For the **Low/Low group**, the relationships between GRE item-type residuals and discriminant functions were:

Function 1 was negatively correlated to Quantitative Comparisons (r=-.58);

Function 2 was positively correlated to Analytic Reasoning (r=.85);

Function 3 was negatively correlated to Antonyms (r=-.67);

Function 4 was positively correlated to Regular Mathematics (r=.60);

Function 5 was positively correlated to Data Interpretation (r=.59);

Function 6 was positively correlated to Sentence Completion (r=.57);

Function 7 was negatively correlated to Sentence Completion (r=-.62); and

Function 8 was positively correlated to Logical Reasoning (r=.59).

For the **High/High group**, the relationship between GRE item-type residuals and discriminant functions were:

Function 1 was positively correlated to Analytic Reasoning (r=.56), and was positively correlated to Reading Comprehension (r=.50);

Function 2 was positively correlated to Quantitative Comparisons (r=.64);

Function 3 was positively correlated to Antonyms (r=.81);

Function 4 was negatively correlated to Regular Mathematics (r=-.58);

Function 5 was not correlated to any of the item-types;

Function 6 was negatively correlated to Sentence Completion (r=-.66), and was positively correlated to Reading Comprehension (r=.54);

Function 7 was positively correlated to Regular Mathematics (r=.71),
was positively correlated to Data Interpretation (r=.66), and
was positively correlated to Reading Comprehension (r=.55);

Function 8 was positively correlated to Data Interpretation (r=.50),
was positively correlated to Logical Reasoning (r=.79), and
was positively correlated to Sentence Completion (r=.60).

Once the relationships between discriminant functions and mean item-type residuals have been established for each group, then the relationships between the discriminant functions and the coursework clusters were determined.

By examining the average score of each cluster group for each discriminant function, the extent to which each discriminant function contributes to that cluster was calculated. Functions which had no correlation with specific item-type residuals were omitted.

Each discriminant function explains a certain proportion of the variation in residual scores. Discriminant functions with strong explanatory power, "good discriminant functions," have large between-cluster variability and low within-cluster variability (Romesburg 1984). The eigenvalues of Tables 13 and 14 present the ratio of between-group to within-group sums of squares of the residuals. Large eigenvalues are associated with the discriminant functions that most contribute to explaining variability in GRE item-type scores.

Wilk's Lambda is the ratio of the with-group sum of squares to the total sum of the squares. It represents the proportion of the total variance in the discriminant function values not explained by differences among cluster groups. Wilk's Lambda serves as a test of the null hypothesis that there is no difference in the mean residuals of a coursework cluster means and the mean residual scores of the coursework in the total sample.

Thus, the eigenvalues and canonical correlations indicate the extent to which each discriminant function contributes to our understanding of the variability in coursework mean residuals. Lambda tests the null of the

differential coursework hypothesis for each discriminant function. Lambda's that were not significant at the .05 level indicated no effect of the coursework cluster on the general learning assessed.

Low/Low Group Course Clusters

Coursework clusters with positive or negative means greater than 1.0 were selected for further analysis.

Coursework **Cluster #1** had high positive means on Functions 1, 3, and 4, and a high negative group mean on Function 2. Function 1 was negatively correlated to Quantitative Comparison (r=-.58). Function 2 was correlated positively to Analytic Reasoning (r=.85). Function 3 was negatively correlated to Antonyms (r=-.67) and Function 4 was positively correlated to Regular Mathematics (r=.60). Therefore, students taking this set of coursework showed declines in Quantitative Comparisons, Analytical Reasoning, Antonyms and improved in Regular Mathematics.

Cluster #2 had a high negative group mean on Function 2 and a high positive group mean on Function 4. Students enrolled in this coursework improved in Regular Mathematics, but declined in Analytic Reasoning.

Cluster #3 had a high positive group mean on Function 3 and a high negative group mean on Function 1. Students enrolled in this coursework lagged in Antonyms and improved in Quantitative Comparisons.

Cluster #4 had high negative group means on Functions 1 and 2. Students enrolled in this coursework improved in Quantitative Comparisons and declined in Analytical Reasoning.

Cluster #5 had high negative group means on Functions 1 and 4. Students enrolled in this coursework declined in Regular Mathematics and showed gains in

Quantitative Comparisons. Cluster 5 contained a Biology coursework (Bio 2 and 101), Chemistry sequence (Chem 13 and 15) and Mathematics sequences (M&CS 4 & 8, 48, and 62 & 64) (See Table 7). The sciences and mathematics predominated this cluster.

Cluster #6 had high positive group means on Functions 1 and 2. Students enrolled in this coursework improved in Analytic Reasoning and lagged in Quantitative Comparisons. Cluster #6 contained an Economics sequence (Econ 51 and 52) and mathematics coursework (M&CS 3, 5, 47 and 63). Comparing clusters 5 and 6 shows that some math and science coursework was linked to gains in Quantitative Comparisons while others were not.

Cluster #7 had a high positive group mean on Function 2 and a high negative group mean on Function 3. Students taking this coursework improved in Analytical Reasoning and Antonyms.

Cluster #8 had a high positive group mean on Function 4. Students enrolled in this set of courses gained in Regular Mathematics. However, there were only three members in this cluster.

Cluster #9 had high negative group means on Functions 2 and 3, but had a high positive mean on Function 1. Students taking these courses demonstrated gains in Antonyms and lagged in Quantitative Comparisons and Analytic Reasoning. This cluster had only four members.

Table 11 demonstrates that for the Low/ group, Functions 1 to 5 explain 95.02% of the variation in residuals. Lambda values were significant at the .001 level with the exception of Function 5 which was not significant in the regression analysis. Functions 1 to 4 were used in the further analysis of the coursework clusters for the Low/Low groups. Given that Functions 1 to 4 were correlated with Antonyms, Analytical Reasoning, Regular Mathematics, and Quantitative Comparisons, it may be inferred that these GRE item-type residuals

were predominant in explaining the coursework patterns of the Women's College Sample #1 Low/Low Group. Examination of the courses associated with changes in general learned abilities suggested that mathematics, sciences and quantitative social sciences (such as Economics) contributed to these changes.

TABLE 11
Canonical discriminant functions: Women's Sample #1, Low/Low Group.

Function	Eigen-value	Percent of Variance	Cumulative Percent	Canonical Correlation	Wilk's Lambda	Degrees Freedom	Signi-ficance
0					.0033	72	.0000
1	4.3992	39.07%	39.07%	.9027	.0176	56	.0000
2	2.9229	25.96%	65.03%	.8632	.0692	42	.0000
3	1.6958	15.06%	80.09%	.7931	.1865	30	.0000
4	1.1053	9.82%	89.91%	.7246	.3926	20	.0000
5	.5759	5.11%	95.02%	.6045	.6187	12	.0018
6	.4347	3.86%	98.88%	.5504	.8876	6	.2569
7	.1194	1.06%	99.94%	.3265	.9935	2	.8094
8	.0065	.06%	100.00%	.0805			

High/High Group Course Clusters

Coursework clusters with positive or negative means greater than 1.0 were selected for further analysis. **Coursework Cluster #1** had a high positive group mean on Function 3 and a high negative group mean on Function 1. Function 3 was positively correlated to Antonyms (r=.81). Function 1 was positively correlated to Analytic Reasoning (r=.56) and Reading Comprehension (r=.50). Students enrolling in this coursework improved in Antonyms but declined in Analytic Reasoning and Reading Comprehension.

Cluster #2 had high negative group means on Function 1 and Function 3. Function 1 was positively correlated to Analytic Reasoning (r=.56) and to Reading Comprehension (r=.50). Function 3 was positively correlated to Antonyms (r=.81). Students enrolling in this cluster declined in Analytic Reasoning, Reading Comprehension, and Antonyms. Cluster #2 coursework was predominated by

the sciences, particularly Chemistry sequences (Chem 13, 14, 15 and 16; Chem 101 & 103).

Cluster #3 evidenced high positive group means on Function 1 and Function 3. Students taking Cluster #3 coursework gained in Antonyms, Reading Comprehension, and Analytic Reasoning.

Cluster #4 had a high positive group mean on Function 1. Students enrolling in this cluster showed gains in Analytic Reasoning and Reading Comprehension. However, cluster #4 had only one member.

Cluster #5 had a high positive group mean on Function 3 and a high negative group mean on Function 2. Recall that Function 3 was positively correlated to Antonyms (r=.81). Function 2 was positively correlated to Quantitative Comparisons (r=.64). Students taking courses in this cluster improved in Antonyms but flagged in Quantitative Comparisons. Cluster #5 coursework was predominated with the social sciences (Econ 51 & 52; Govt 17, 90, 102; Psyc 49, 81; Sosc 93) (Table 8). It should be noted that Bio 63, Econ 51 & 52, Govt 17 and M&CS 3, 5 and 47 were linked to Quantitative Comparisons gains in the Low/Low group (Table 7) while they were associated with Quantitative Comparisons declines in the High/High group.

Cluster #6 encompassed a high negative group mean on Function 1, and a high positive group mean on Function 2. Students signed up for this coursework pattern declined in Analytic Reasoning and Reading Comprehension but gained in Quantitative Comparisons.

Cluster #7 had high positive group mean on Function 2 and high negative group means on Functions 1 and 3. Students taking this coursework pattern gained in Quantitative Comparisons, but declined in Analytic Reasoning, Reading Comprehension, and Antonyms.

Cluster #8 involved a high positive group mean on Function 2 and a high negative group mean on Function 1. Students taking these courses rose in Quantitative Comparisons but declined in Analytic Reasoning and Quantitative Comparisons. However, Cluster #8 had only two members.

Cluster #9 produced high positive group means on Functions 1 and 2, and a high negative group mean on Function 3. Students enrolled in this coursework tended to improve in Analytic Reasoning, Reading Comprehension, and Quantitative Comparisons and lag in Antonyms. Math and Computer Science coursework predominated in this cluster (See Table 8). Certain M&CS coursework was found in both the High/High and Low/Low groups to be linked to gains in Quantitative Comparisons (M&CS 4, 8, and 64).

Table 12 indicates that for the High/High group, Functions 1 to 4 explain 96.05 percent of the variation in residuals. Lambda values were again significant at the .001 level. However, Function 4 was not significant even though it accounts for 9.47 percent of the variance. Functions 5 to 8 individually account for less than 5 percent of the variance. Thus, only Functions 1 to 3 were used in the analysis of the coursework clusters. Since these functions were correlated with Reading Comprehension, Antonyms, Quantitative Comparisons, and Analytic Reasoning, it suggested that these GRE item-type residuals were predominant in explaining the coursework patterns of the Women's Sample #1 High/High group. Antonyms, Analytic Reasoning and Quantitative Comparisons were the prevalent areas of gain in both the High/High and Low/Low groups of Women's College. Also, Low/Low students showed gains in regular mathematics, while High/High students evinced improvement in Reading Comprehension. The predominance of Analytic Reasoning, Reading Comprehension and Quantitative Comparisons were also comparable to students examined at a research university (Jones & Ratcliff, 1990) and a comprehensive college (Ratcliff &

Jones, in press).

It should be cautioned that the association was established at the cluster level. No direct causal link is intimated between student enrollment in any one given course and scores on the GRE. Furthermore, at this point, one cannot say why students who enrolled in these courses had higher residuals. The cluster serves to hypothesize relationships between coursework patterns and the general learned abilities measures by the item-types of the GRE. **One can say that students who enrolled in specific patterns of coursework tended to evidence stronger gains on specific GRE item-types, while others who enrolled in different coursework patterns did not tend to show such gains.** This evidence affirms the hypothesis that student gains in general learned abilities are associated, positively and negatively, with the coursework in which they enrolled. Further analysis is required to determine the nature of these associations.

TABLE 12
Canonical discriminant functions: Women's Sample #1, High/High Group.

Function	Eigen-value	Percent of Variance	Cumulative Percent	Canonical Correlation	Wilk's Lambda	Degrees Freedom	Signi-ficance
0					.0054	72	.0000
1	3.5787	34.15%	34.15%	.8841	.0245	56	.0000
2	2.9294	27.96%	62.11%	.8634	.0964	42	.0000
3	2.5642	24.47%	86.58%	.8482	.3435	30	.0000
4	.9924	9.47%	96.05%	.7058	.6844	20	.1078
5	.2583	2.47%	98.52%	.4531	.8611	12	.5235
6	.1075	1.03%	99.55%	.3116	.9537	6	.7431
7	.0379	.36%	99.90%	.1910	.9898	2	.6847
8	.0103	.10%	100.00%	.1009			

Conclusion

In this paper we examined gains in nine measures of general learning to determine if they were associated with any single set of subjects or coursework. We looked at two different levels of student abilities (the High/High and Low/Low groups). We sought to determine if the views of the core curriculum advocates or the advocates of the distributive requirements more fully explained the extent of general education coursework associated with gains on the general learned abilities among the two groups of college students. If all Women's college students were to benefit from a single set of general education coursework, the cluster analysis would produce such a core among all coursework taken. This in fact did not occur. Logical sets of courses were found among the different ability groups of students. Certain mathematics and science courses (Bio 63, Econ 51 & 52, Govt 17 and M&CS 3, 5 and 47) were found to have opposite effects on the two groups of students. Other coursework was found to have comparable effects on both groups of students (M&CS 4, 8, and 64). The cluster resulting from the analysis of the total sample was less discrete and logical than those of the subgroups.

It may be argued that the Graduate Record Examination item-types do not reflect the goals and intention of general education coursework at Women's College. It can be further argued that such goal-based evaluation of coursework would produce a cohesive core of courses associated with gains according to college general education goals. Indeed, this may be so. However, Women's College had not identified any such measures of general learning for its students. While it did have broad goals for its general education curriculum, it had no way of assessing them. So, we turned to the most widely used measures of post-college general learned abilities. While not all Women's College students plan graduate study, sizeable proportions of the Women's College students did plan further study. Regardless of whatever local goals a college

may have for its general education curriculum, it must also serve to prepare students for post-baccalaureate study. Our findings are exploratory. Ideally, subsequent cohorts of graduating seniors at Women's College should be assessed using a combination of nationally-normed measures (such as the GRE) and measures reflecting the goals and purposes of the general education curriculum as articulated by the faculty.

Our findings argue against the establishment of a core curriculum. The results support the view of the advocates for distributive requirements in general education because students who showed gains in the High/High group did not take the same coursework as those who gained among the Low/Low group. However, it does not support the current use of a wide range of options in a distributional general education requirement. Instead, it suggests that discrete arrays of coursework be identified which are more appropriate and productive for different ability levels of students. This conclusion was manifest in the findings of the analysis of high and low ability students. These findings also confirm those in a similar analysis of graduating seniors at a selective research university, "Women's University" (Jones & Ratcliff, 1990) and a comprehensive college with professional school programs, "Northern College" (Ratcliff & Jones, in press).

In the majority of cases, Women's College coursework chosen by high ability students led to gains in learned abilities, as measured by the GRE. The converse was true for the low ability students; here the majority of coursework chosen did not lead to gains in general learning. Nevertheless, discrete sets of coursework were identified that were beneficial to these students. These results suggest the need for greater academic advising in undergraduate course selection or greater prescription in the curriculum. Again, these findings paralleled those of the Northern College and Western University studies. The

cluster analytic model can be used to identify coursework which has been beneficial to students of specific ability levels, interests and aptitudes.

The secondary validity of the cluster analyses of Women's College High/High and Low/Low ability subsamples were comparable. Roughly 9 of each 10 courses analyzed were accurately grouped according to differential effects in the general learned abilities of students. Taking different patterns of coursework does lead to different types and levels of development. Most of the coursework taken in common by 5 or more high ability Women's College students led to gains. Conversely, most coursework taken in common by 5 or more low ability Women's College students led to declines in general learned abilities.

This study used the 9 GRE item-types as multiple measures of general learned abilities. The GRE item-types generally provided reliable measures of learning. Rarely did the GRE score predicted by the SAT exceed the actual highest score possible on the GRE. This study, like that of Western University and Northern College, generally affirmed the use of GRE item-types as discrete measures of general learning.

Student transcripts, generated from a student records database, provided a powerful, non-obtrusive description of the curriculum experienced by undergraduates. Research linking coursework and assessment information needs to be continued longitudinally to establish <u>trends</u> in course patterns over multiple years of graduating seniors. Through such trend analysis, the extent to which general learning is influenced by student course-taking behavior can be more firmly established.

Neither a prescribed core curriculum nor a "free choice" distributional system was justified by our research at Women's College. Nevertheless, clear sequences and combinations of coursework do emerge from this research. Quantitative abilities are not developed solely in lower division mathematics

courses, but are enhanced through an array of select applied science, social science and business courses as well. General learning is not confined to one lower division; upper division causes contributed strongly to the development of specific learned abilities, particularly Analytic Reasoning.

Women's college students showed gains in general learned abilities comparable to those at those other types of institutions. Those other institutions were coeducational. The high variability in the Data Interpretation item-type at Women's College differed from the findings at the other two institutions. Further investigation of this type of learning may be warranted, albeit with a more reliable measure that the Data Interpretation item-type of the GRE. The predominance of science and mathematics coursework in the explanation of gains at Women's College was also noteworthy. Clearly, there were strong links between gains in quantitative measures and these courses, suggesting a unique profile of effective coursework for Women's College.

Students at Women's College, like many universities and colleges, do not share much common formal learning experiences. From 15 to 20 percent of the coursework on one student's transcript was shared with 5 other students from the same sample. The lack of a common intellectual experience is only problematic to the extent it is held as an institutional value. Indeed, it is the mark of a broad college curriculum to preserve and advance the full landscape of fields and disciplines of inquiry. Yet, we must advance beyond the days of Charles Elliot and Ezra Cornell. The vastness of curricular choice can be either an asset or a liability, depending on the extent to which it effectively advances student learning.

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